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WEB-BASED APPLICATION FOR ENHANCING ON-SITE AND REMOTE DATA COLLECTION PROCESS DURING PANDEMIC: AN EXPLORATORY STUDY

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Abstract

The COVID-19 pandemic has changed the way data collection for research takes place around the world. Such adaptation has forced a turn of research methodologies in conducting research. This study focuses on on-site and remote digital data collection methods that can be adopted during the pandemic. The method of research and data collection often requires a group of researchers to travel to a specific site to meet communities for data collection, which is not permissible during the pandemic. This paper explores the use of web-based application for documentation of the existing natural and built features, and land management system for identification of the rural community's land information. In this paper, the use of a web-based application, namely i-LULACAST, is highlighted. The application was designed and used for data entry and management of the rural community with fewer human resources on-site while still maximizing the number of datasets needed for analysis. The system was built using Codelgniter Application 4.0.4 to develop libraries to link databases and perform operations such as data entry, location, and uploading pictures for particular data. This system has also shown prospects for other purposes, such as census, landscape data entry, and contact tracing for medical purposes.

***Keywords**:* data collection, Covid-19, digital, rural, pandemic

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INTRODUCTION

In response to the COVID-19 pandemic, the Malaysian government enacted a Movement Control Order (MCO) on March 18, 2020 (Prime Minister's Office of Malaysia, 2020). The decree imposes restrictions on all inbound and outward travels, a nationwide prohibition of mass meetings, as well as the closure of all public and private educational institutions and government offices (Tiong & Sim, 2020). During MCO, the government also announced a lockdown, and policy requiring citizen to stay home if sick, practice good hygiene, maintain a social distance of 1 meter from others, and wear a mask. The influence of lockdown has changed the nature of the research, in this case, from site visit, the researcher needs to conduct hybrid or online data collection. Many researchers need to suspend data collection or re-design their projects considering social-distancing measures (Norzailawati, 2021).

On-site questionnaires and interviews are among the traditional data collection techniques that can address the datasets needed from a particular community. These methodologies, however, became infeasible due to the pandemic as many data collection initiatives and routine surveillance must be postponed indefinitely. The MCO restrictions have consequently imposed an enormous challenge to researchers in terms of cost and time. To ensure a research's timeline is fulfilled and the project can continue, alternative methods need to be proposed to facilitate the coordination among researchers and the community. Such shortcomings have imposed big challenges in rural areas for many countries, including Malaysia, as the Internet suddenly become a necessity.

Various technologies such as big data, Internet of Thing (IoT), mobile internet, and cloud computing can be used for data collection. Mobile-phone surveys allow the users to collect real-time data on behavior, exposure, knowledge, and perception, as well as care and treatment, to help the researcher make better decisions (Phadnis et al., 2021). Other technologies that were developed include the virtual data collection for COVID-19 purposes, including pandemic planning, surveillance, testing, contact tracing, and quarantine monitoring (Sosa et al., 2021; Whitelaw et al., 2020). Other studies included data on lifestyle, activities, habits, and environment (Canino et al., 2016), health monitoring (Nugroho Joshua et al., 2017), daily trips and activities information (Piras et al., 2018), and medical delivery in Sri Lanka (Phadnis et al., 2021). Phadnis et al.'s (2021) study particularly found the ability of a mobile-phone survey to facilitate rapid data collection. The mobile-phone survey can be conducted without face-to-face contact with the respondents, hence its suitability to be used during the pandemic. According to Minaar and Heystek (2016), using online surveys for academic research should be acknowledged internationally as practical and affordable. An open-source suite for data collection, KOBO toolbox researcher to collect the data by using 'one click method' and can compile the

data based on the predefined criteria of the research (Lakshminarasimhappa, 2021). However, this web-based application is different as the other technologies as it was answered by the rural residents and its ability to take photos and locate places.

This web-based application was designed to cope with the restriction of movement in the study area. This application allows the data to be collected through minimal direct contacts and interactions with the targeted users or respondents. The study aims to explore the use of a web-based application via mobile phones for land management and a landscape character survey that was to be conducted in a rural area during the pandemic. The objectives of this paper are i) to use the web-based application to collect datasets for land management and a landscape character survey, and ii) to transfer and mapping both datasets using GIS. This study explores the application of the web-based system by selecting six villages under Sultanate Land that is in Pekan town in the state of Pahang. The innovation of the web-based mobile application was crucial because the research team was based in Kuala Lumpur, about 280 kilometres away from the case-study area.

DATA COLLECTION

The case study of this research is the Sultanate land in Pekan town. For the land-use survey, the respondents selected are all villagers who live in this land. The villagers need to fill in the survey form to update information regarding the owner or renter of the land. Due to the restrictions of traveling during the fieldwork phase of the research, only a limited number of researchers could travel to the site. The robust nature of i-LULACAST made it easy for the research team to obtain the data, whether by sourcing it from the locals' and research assistants' smartphones or by having a local representative to assist the locals to fill in the data from a computer.

To monitor the research remotely, the team appointed the liaisons officers from the Sultanate Office and the representative from each village to explain the purpose of the study. They also distributed the questionnaires to all homes in the study areas by providing the link and Quick Responds (QR) codes media, and social media platforms, such as Facebook and Whatsapp. Another action taken was to distribute flyers and booklets to each home in the study area. For those residents who has no smartphone, they will respond to the system and the representative will visit to the respective home or fill in the questionnaire using laptop or a computer. As a result, this approach will increase the outreach to the rural residents who lack technology.

WEB-BASED APPLICATION FOR DATA COLLECTION

The web-based application had to be user friendly and developed with specific parameters that could facilitate the data collection and analysis. Thus, this study developed the web-based application survey, namely IIUM Land Use and Landscape Character Survey Tool (i-LULACAST), for the data collection and analysis. The detailed information focused in this application particularly covered of two main aspects: (i) the owner of each lot in the rural area for land management, and (ii) the landscape character of the rural area for site analysis. This application was developed as an alternative to on-site fieldwork data collection. The key components of the database have been identified and will be developed and transferred to a Geographical Information System (GIS) application for land management purposes and landscape character analysis and will be coordinated through the application according to ArcGIS and MapInfo formats. The data are also transferrable to Google Earth.

The system was built using Codelgniter Application 4.0.4 as a PHP MVC framework to develop libraries to link databases and perform operations such as data entry and location and uploading of pictures for particular data. The optimisation of web-based application for data collection was high among the researchers due to the movement limitation caused by the pandemic. The application, called i-LULACAST, was intended to be used in two ways. Data entry can be done using any smartphone with access to the Internet. The land-use survey data were to be filled in by the local residents, while the landscape character survey questionnaire was to be filled in by trained local research assistants. The collected data then can be accessed and retrieved by the researchers from their laptops. Since the data entries were updated automatically in the database, the researchers could monitor the data progress in real-time.

The framework of the system focuses on the functions and steps for adding users and selecting the data needed to be filled by users or experts regarding the analysis for the rural area (Fig. 1). The user and expert need to register and log in. The user, the occupant of the house, in this case, needs to input the data in the form. For land management, the details of data input include the name, identification number, address, rental or ownership status, phone number, duration of residency, number of households, tax number, year built, and house type. Since the house addresses are geotagged, all of the data can be automatically transferred to the GIS platform. For the landscape character survey, the expert and trained local research assistants will identify the landscape elements on the site, such as vegetation, structure, building, culture, visual and public space. These datasets will be transferred to Google Earth and the GIS platform for mapping.

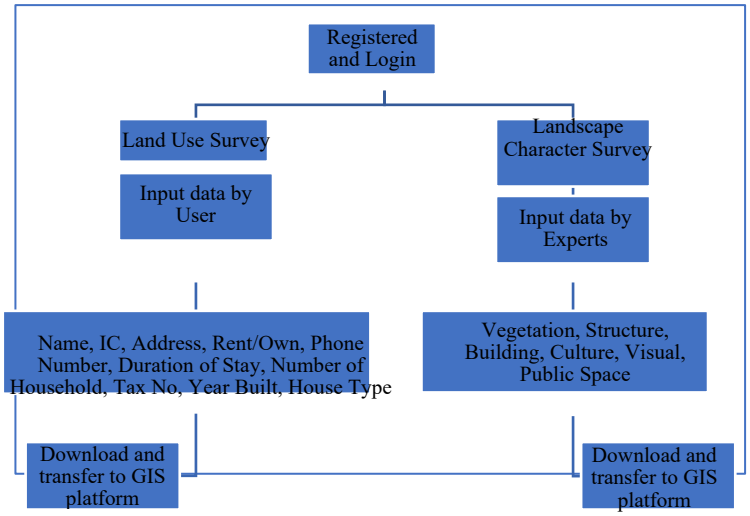

Figure 1: Flowchart of i-LULACAST web-based system

i) Land Use Dataset

The data collection was conducted from March to May 2021 using the i-LULACAST application. This web-based application was developed to facilitate the data collection process by considering the pandemic situation. A link to the web application was given via social media groups, which included the village head and other JKKK members. The link was then distributed to all members of the particular village for them to fill in the data from their homes. For security purposes, the user needed to register him/herself and the village name. The password was prepared by the administrator and distributed to the occupants. With regard to land-use information, some of the datasets required were the house's location, occupant's name, occupant's identification card, phone number, and lot number. Other information needed were the year of the house built, type of house, year occupied, duration stay in that particular house, total household, photos, and land tax number.

ii) Landscape Character

The landscape character survey is another important component of the research. While the land management survey documented the occupancy of the study area, the landscape character survey documented the existing natural and built features of the site. Based on a preliminary study of the significant components that need to be mapped on-site, the research team delineated five primary components: (i) location details, (ii) vegetation, (iii) buildings, structures, and public spaces, (iv) culture, and (v) visual. Other relevant data—such as topography, hydrology, land

use, and others commonly mapped during the site inventory process—were omitted from the application because these kinds of data can be obtained from secondary sources and are not necessary to be mapped on-site. For each component, the experts or trained research assistants can fill in the descriptions and evaluations of their observations (similar to writing down field notes), upload multiple photos, and geotag the locations. The application can map the data directly according to the coordinates of the location and attach the information and photos that were keyed in from the smartphones. Then, this data can be accessed and downloaded in the form of a spreadsheet and transferred to Google Earth or GIS for mapping and analysis.

DATA ANALYSIS

The levels of login to i-LULACAST are divided into two parts: the administrator and the user. 'Admin' is the administrator who manages the system, which is part of the research team. 'User' is the occupant of the houses in the study area and the trained research assistants. The application was developed to support data collection via survey with security features (https, cloud server, admin roles and password controls). The interface of the login page is shown in Fig 2.

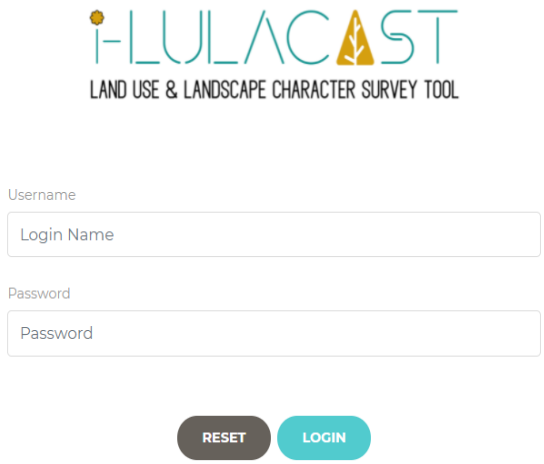

Figure 2: The login page of 'i-LULACAST' for both Admin and User

The Dashboard application (Fig. 3) was used to view the registered users. In this interface, the total users, as well as the number of entries for both land use and landscape survey, can be seen. This dashboard can be seen by the administrator only. The summary of users who key in the particular information can be seen under 'land survey' records by villages, while the number of data

collected for landscape character survey can be seen under 'landscape survey' records.

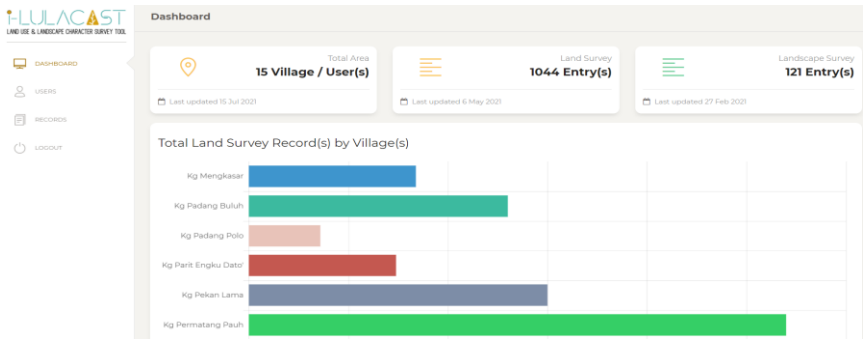

Figure 3: The dashboard application 'i-LULACAST'

i) Land Use Survey

This interface is the view seen by the users (Fig. 4). The users were required to fill in all of the datasets and also take photo of their house. All the datasets were kept in the servers and will be exported to the GIS platform for the development of database for data management. The users need to be in their home and click on Locate button to capture the coordinate.

Using a centralized platform, web-based information portal improved the number of users required to fill in the data. At least 75 percent successfully filled in the form. The data indicate that 937 users out of 1152 total ownerships (including houses, agricultural land, commercial and institutional areas) filled in the form. Some of the areas could have an unstable internet connection; these locations therefore, were pin-pointed by the users not on the exact location.

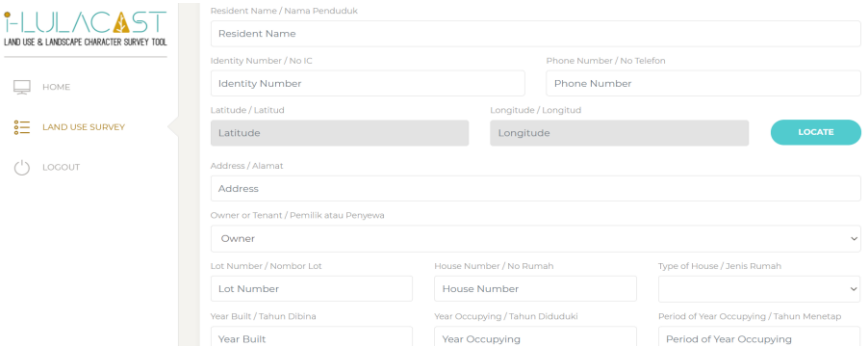

Figure 4: Types of datasets needed in the study

The key components of the database were identified and were developed and coordinated through the application and according to ArcGIS and MapInfo formats. All of the occupants' information were matched with their particular houses on the GIS map so the occupants' updated information can be kept and used by the authority for land management purposes. The data collected were then extracted from the spreadsheet and transferred to GIS for further analysis. The xy coordinate of each particular house are extracted as below (Fig. 5).

However, several limitations of the web-based application were found. The limitation of the internet network precluded the data from being submitted at the occupants' homes. The occupants also had to fill in the overlapped data for similar information, hence the need for data screening. Another limitation was the users' unfamiliarity with how to key in the datasets, as they come from rural areas. Susceptible groups, including the elderly, are less likely to have a mobile phone and may not be able to use such an application. Some of the elderly also stay in their house without their children, who work in different area or state; this group of occupants (the elderly) would need further assistance from the research team. In this case, the chief village distributed his team members to visit those particular houses to ensure that every information of the occupants was successfully included in the system.

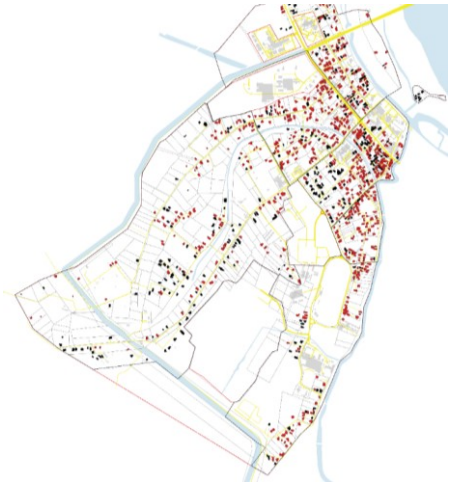

Figure 5: Point data for individual house

ii) Landscape Character Survey

For the landscape character survey, the admin set an account for each of the experts and trained research assistants. Each person was given a guide for the

landscape character survey and briefed on how to use the application (Fig. 6). They were then assigned to collect the data at the site. The technique is the researcher could document all or any of the relevant components for a particular spot. For example, for Site A, Researcher No. 1 could document the location details, vegetational characters, buildings, structures, public spaces, visible cultural activities, and visual qualities. This could be done by a trained person with a smartphone and Internet access. All entries are required to have location details so that all the data can be mapped to their locations.

The data collected were then extracted from the spreadsheet and transferred to Google Earth via the plotted coordinates (Fig. 7). The research team then categorized the data into two major aspects: accessibility and zones. Accessibility comprises critical entry points, primary and secondary access routes, and transition points between the zones. Zones comprises the palace and administrative zone, and the village zones. Based on the documented photographs, descriptions, evaluations, and locations, the researchers then analyzed the collected data based on the research aims and objectives.

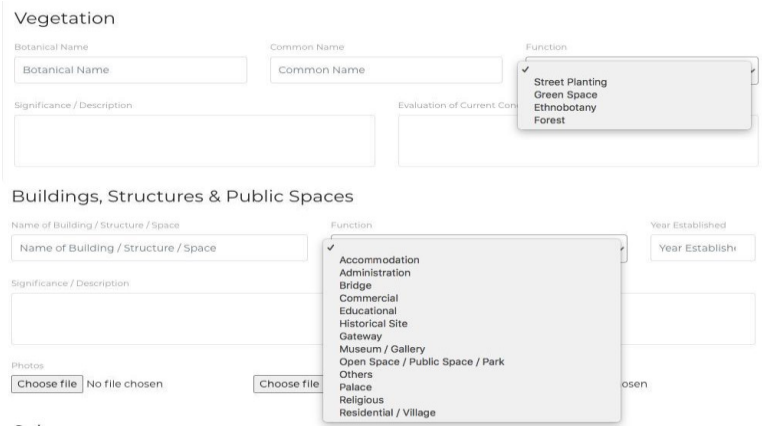

Figure 6: Example of datasets for landscape character survey

Figure 7: Example of data mapping from i-LULACAST to Google Earth

By using i-LULACAST for the landscape character survey, the researchers found three advantages and two limitations. The advantages of i-LULACAST are that it is collaborative, easy to use, and able to map data digitally. First, the collaborative nature of the application allows multiple users to key in data simultaneously or at different times, and at the same or different locations. Fieldwork can be done by as little as one or two researchers or by as many numbers of researchers needed. Second, since i-LULACAST can be accessed using most smartphones with an Internet connection, the application can be used easily by researchers and trained research assistants. The application's components are user friendly in that users only need to type in their observation notes and upload photos from their smartphone cameras. Locations can be plotted both from the address keyed in the application or from the location detected in the GPS. Third, i-LULACAST documents the data entries can be mapped digitally with the coordinates and retrieved for analysis. Conventional manual mapping would require site data to be plotted physically on a map or documented through field notes and aided by a hand-held GPS for coordinates. The use of i-LULACAST enabled the researchers to obtain all these data by using a single application.

Nevertheless, as a newly developed web-based application for landscape character survey, i-LULACAST still has some limitations. First, due to the weak signals in certain parts of the rural area, some of the coordinates were not accurate. This was solved during the data cleaning stage where the researchers replotted the coordinates based on the address keyed in the database. Second, the quality of the photos highly depends on the quality of the smartphone used during the data collection. For inventory and analysis purposes, most of the photos documented in the study were sufficient for analysis. However, for presentation purposes, only high-quality photos could be used.

DISCUSSION

The restrictions of the pandemic have provided an opportunity for researchers to propose new methods for on-site and hybrid data collection. In the pre-pandemic time, a research team would typically be the main actors that collect data on-site and the locals would be the respondents, with little or no interaction with the research instruments. i-LULACAST serves as a digital platform for a wider crowdsourcing of research data where the locals can directly engage with the research instrument. The use of this web-based application also provides an opportunity for a research team to empower the local community as representatives to guide other local respondents on how to use the application. In this study, the chief of villages, the JKKK, and the local research assistants were briefed and trained on how to use i-LULACAST. Some of the residents never had the chance to key in their information online, as this project marked their first

experience. The knowledge-transfer process was a trajectory of the research that was not initially planned as part of the methodology. However, this application has become a significant part of the contributions of the research to the locals of the study area.

The potential of this web-based application is this application can be used as a long-distance survey that can reduce the cost of the data collection. However, the limitation of this application is that some areas was limited internet connection, thus the location provided is not accurate. Low internet connection will provide a not accurate Global Positioning System (GPS) location when transferred to GIS software. This issue can be improved by providing a fast internet connection in any places around Pekan town area.

The strength of this application is it is paperless work. It only requires android phone and minimal understanding in filling in the data, so the researcher able to do long distance data collection. It is also time consuming as all the data will be collected in the server as cloud data. The application also able to locate the location of the houses with the availability of GPS. With the use of application, this research also able to reduce the cost for data collection, including for remunerators dan mobility.

CONCLUSION

The effectiveness of the web-based application has been demonstrated in this study since its operation is simple and easy to understand by persons of different ages and levels of education. This technology does have the potential to be used for other applications, such as census, landscape data entry, and medical contact tracing. This i-LULUCAST web-based application can be optimised in a flexible manner by the researchers particularly in the challenging times that limit the possibilities of on-site groundwork and direct community engagement.

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